DOCUMENT RESUME

ED 230 168 IR 010 680

AUTHOR Grabow, Chad Lee C.
TITLE Computer Science Curriculum Development Guide.
PUB DATE Dec 82
NOTE 47p.; Best copy available.
PUB TYPE Dissertations/Theses - Undetermined (040) -- Guides - Non-Classroom Use (055)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Adoption (Ideas); *Change Strategies; *Computer Science Education; Course Descriptions; *Course Evaluation; *Curriculum Development; Curriculum Problems; Learning Activities; *Objectives; Sequential Learning; Units of Study
IDENTIFIERS *Goal Analysis

ABSTRACT

This guide provides specific information and resources for course and curriculum development, beginning with an outline of the basic elements of a curriculum and a listing of exemplary curricula in computer science education from other colleges. The definition of, need for, and essential and secondary features of a goal are presented, as well as the relationship of the curricular plan to institutional and professional goals. The sequence of curriculum planning steps are discussed, including goal analysis and revision; definition of performance objectives; performance objectives derived from goals; goal analysis to sequence learning; instructional objectives derived from goals; sequence of performance objectives; and analysis of goals for learning styles. A plan for the adoption of curriculum is then described, including a sample presentation to peers, sample goal hierarchy for related fields, and a step-by-step procedure. Fifteen factors involved in reducing resistance to change are summarized. Finally, a sample unit of instruction presents a performance objective, explanation of how objectives and learning activities are different, a sequence of instructional objectives, and a unit of instruction which includes three examples of a learning strategy, an outline of a unit, and evaluation methods. A 9-item annotated bibliography is included. (LMM)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED230168

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Computer Science Curriculum Development Guide

Presented to
Dr. James Ratcliff
in Partial Fulfillment of
Higher Education 562
Iowa State University

December 1982

By

Chad Lee C. Grabow

IR010680

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Chad Lee C. Grabow

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Curriculum Plan Outline

1. Introduction:

   a. Elements of a Curriculum
   b. Exemplary curricula from other colleges

2. Outcomes:

   a. Need for goals
   b. Definition of a goal
   c. Relation of curricular plan to institutional and professional goals

3. Sequence:

   a. Goal analysis and revision
   b. Definition of performance objectives
   c. Performance objectives derived from goals
   d. Goal analysis to sequence learning
   e. Instructional objectives derived from goals
   f. Sequence of performance objectives
   g. Analysis of goals for learning styles

1. a. Elements of a Curriculum

Components:

Eisele	Dressel	Wiles
Objective	Defn of Objectives	Purpose
Procedures	Selection of Obj.	Objectives
Implementation	Organization of Experiences	Evaluation
Feedback	Evaluation	Expectation
Implications		

Similarities:

Objectives, Procedure, and Evaluation.

Differences:

Implementation, Implications, Purpose, and Expectation.

Short Discussion:

Although the three structures differ in the number of components, the basic ingredients of objectives, procedure, and evaluation are present. After reading the references, the author of this paper considers the basic three components mentioned above as the minimum when considering curriculum. The authors of the above references are using the terms in a similar manner. It is interesting how the authors appear to stress unique aspects of their presentation. For example, Eisele looks into implications. Therefore, a curriculum designer may tailor make the curriculum design around the three basic components.

References:

Eisele, James E. "Computer Assisted Planning of Curriculum and Instruction", Educational Technology Publications, Englewood Cliffs, New Jersey, 1971, LB 1570 E4.

Dressel, Paul L., "College and University Curriculum", McCutchan Publishing Corp., Berkeley, Ca., 1971, LA 226 D817C2.

Wiles, Jon and Bondi, Joseph; "Curriculum Development - A Guide to Practice; Merrell Publishing Co., Columbus, Ohio, 1979.

1. b. Exemplary curricula from other colleges

Components:

ACM	DPMA	PLUG
Rationale	Course Description	Purpose
Objectives	Student Outcomes	Objectives
Instructional Notes	Course Content	Content
Topics	Course Approach	Grading
Evaluation Weighting	Evaluation Weighting	Schedule
		References

Short Discussion of Each:

1. Objectives/Student Outcomes - What the student should walk away with upon completion of the course. This could be represented by knowledge, motor skills, or an appreciation for example.

2. Content/Course Content - The material the student will read, discuss, assimulate, and add to his/her knowledge base throughout the length of the course.

3. Evaluation Weighting/Grading - The criteria used by the instructor to evaluate the student based on the goals and objectives of the course and assignment of a grade.

4. Rationale/Purpose - Informs any potential student why the course is offered.

5. Instructional Notes - These are specific guidelines that an instructor may use in the presentation of the course based on past experience of former instructors.

6. Schedule/Course Approach - A structured list of topics with a corresponding time frame.

7. References - A list of resources a student may turn to in persuing additional knowledge about a topic.

1. b. Exemplary curricula from other colleges (Cond't)

References:

ACM - Couger, J. Daniel, "Updated Information Systems Curriculum Guidelines", Computing Newsletter, College of Business Administration, University of Colorado, Colorado Springs, Colorado, April, 1982.

Curriculum '78, "Recommendations for the Undergraduate Program in Computer Science - A Report of the Association of Computing Machinery (ACM) Curriculum Committee on Computer Science", Communications of the ACM, March 1979, Vol. 22, Number 3, pp. 147-165.

DPMA - DPMA (Data Processing Management Association) Model Curriculum for Undergraduate Computer Information Systems Education, DPMA, Park Ridge, Il., 1981.

PLUG - Schultz, Brad, "Model D.P. Curriculum Welcomed by Colleges", Computerworld, p. 12, Oct. 5, 1981. PLUG (Pittsburgh Large User's Group).

2. a. Need for goals

Goals are desirable outcomes. Goals are statements of central intent or purpose. Goals are written for many levels. There are national goals, such as those proposed by professional organizations, national agencies, and even legislative bodies. There are state goals proposed by these same groups. There are subject matter (content) goals. There are individual goals (personal development) and class goals (instructional outcomes). There are college goals, programmatic goals, and department goals.

It is a term used to describe many desired or planned outcomes, but the exact attributes of this concept are not as easy to define as are instructional objectives written in performance terms. The curriculum designer must be concerned with how abstract should goals be, should goal statements include a target audience, and should a goal statement include criteria? (Course notes authored by Dr. James Ratcliff, Curriculum Development in Colleges.)

To illustrate the need for goals, the author of this paper shall offer a critique of Arthur W. Chickering and Associates, The Modern American College (1981), p. 4-5.

The article discusses the need for change in our institutions. It references historical works from 1852 and brings the reader to the present day. A review of our present situation in terms of resources and allocation puts the article in perspective. The article stresses that outcomes can no longer be assumed to be natural by-products of institutional business as usual. The need for goals is explicit. One who is designing curriculum cannot assume that a product or outcome will transpire at the end of course of instruction. Goals must be developed with great care and direction. Establishment of goals is essential in curriculum design. Although the Chickering article is identified with institutions at the national level, the theme of the article can be directly related to colleges, department, and courses.

2. b. Definition of a goal

Definition:

A goal is a statement of expected outcomes that express a central purpose or aim; in that sense they are general. However, a goal need not lack specificity in terms of what they intend to achieve. The goal usually centers around a theme, expresses direction, and is directed to a target audience. Goals may also include or refer to a time frame.

Essential Features:

A goal should be stated as general as possible - This allows for flexibility for minor change. It should be a brief statement without to much detail.

A goal should state a desired outcome - One should know what s/he will leave with when the course is finished.

A goal should define what the target population is - This could be directed to a student, course, or institutional centered.

Secondary Features:

A reference to a time frame.

Do not get to specific; do not include objectives.

2. c. Relation of curricular plan to institutional and professional goals

Levels of Goals For Computer Science

National: To develop a nationally recognized and accepted model curriculum for undergraduate Computer Information Systems education for the 1980's (DPMA's Model Curriculum Project, Revised October, 1980).

State: To provide college/university graduates with a basic level of computer literacy. (Speech; Dr. Jack Hamm, State meeting of the DPMA Chapter, Little Rock, Ark., 1982).

Professional Organization: To provide graduates with the knowledge, abilities, and attitudes to function effectively as applications programmers/analysts, and with the educational background and desire for lifelong professional development. (DPMA Educational Foundation Committee, 1981).

Sub-area of Specialization: Information Resource Management - To provide students with useful insights for relating the activities of programming and systems analysis and design to a set of management requirements.

College: To provide students an opportunity to study Computer Science through formal coursework. Students shall obtain a basic level of computer literacy.

Department: To provide students with the knowledge, abilities, and attitudes to function as applications programmers/analysts.

Course, Seminar, Workshop: Students will design and implement applications that utilize structured algorithms.

Unit or Module: The student will know the concepts of top-down program development and functional decomposition.

3. a. Goal analysis and revision

Analyze a goal statement for various domains of learning. Revise goal statements to incorporate each appropriate domain.

Goal: Students will design structured algorithms.

Domain Characteristics:

KNOWLEDGE (Content): Control Structures, Flowcharting Symbols, Design Approaches, Design Documents, Advanced Programming Techniques.

SKILLS (Psychomotor): Draw, Print, Speak Clearly and Effectively, Keypunch, Reading, Obsveration.

ATTITUDES (Affective): Organization of values and development of ideas based on content- Methodology. Healthy group interaction.

ABILITIES (Cognitive): Recall Structures, Symbols, Approaches, Documents, Advanced Programming Techniques. Apply tools to design algorithms. Synthesis into a design.

Revised Goal: Given a data processing application, the student will analyze the problem using structured tools and design the solution in structured algorithm format.

3. b. Definition of performance objectives

Basic Definition of Performance Objective: The Performance Objective should state who is to perform, the actual behavior, the result under defined conditions and the standard to be used for evaluation. (Close to Kibler's definition - Behavorial Objectives and Instruction.)

Advantages: Defines the audience; students know what is expected for an outcome; teacher knows conditions and standard measure; clearly stated, defines the content for students and instructor. Objectivity, evaluation, validity, and accountability.

Explanation: The advantages are stated so they may be directly related to the underlined tasks or the definition. The advantages must be organized in a meaningful format for the student and instructor.

Disadvantages: Does not state individual needs. Fails to identify/specify important performance objectives. Fails to associate utility of mastery. Hard to make objectives relevant to task. Does not state proper communication of teacher objectives to students. There is no priority of objectives.

Explanation: Simply stating performance objectives are not valid unless they match the goals, are communicated adequately, relevent to the student, and objective itself. These disadvantages can be implemented into the above definition if thought out beforehand.

Sample Performance Objectives:

1. After completing this lesson, the student will draw and write the names of 10 of the 15 flowcharting symbols.

2. Students will draw accurate structured flowcharts of algorithms from case study problems.

3. c. Performance objectives derived from goals

Step 1 - Goal:

Given a data processing application, the student shall analyze the problem using structured tools and design the solution in structured algorithm format.

Step 2 - Elements:

Flowchart Symbols and Relationships
Analysis and Design Procedures
Flowchart Design Structures
Design Documents
Design Approaches
Structured Walk-Through

Step 3 - Performance Objectives:

a. The student will identify 10 of the 15 flowcharting symbols' names and relationships.

b. The student shall explain, in his/her own words, the three structured design approaches.

c. The student will draw the three basic control structures.

d. The student will organize the facts and develop a solution based on Analysis and Design Procedures for a given problem.

e. The student will draw and write design documents to support their solution.

f. The student will interact as a member of a Structured Walk-Through Team and discuss the solution and offer recommendations.

3. d. Goal analysis to sequence learning

Performance objectives written at all levels of the cognitive domanin of the taxonomy of educational objectives.

Topic: Structured Methodology

Goal: Given a data processing application, the student will analyze the problem using structured tools and design the solution in an structured algorithm format.

Objectives - Cognitive Domain:

KNOWLEDGE: The student will define, in one sentence, the Structured Theorem.

COMPREHENSION: Upon reading the case, the student will destinguish the applications major inputs, processes, and outputs.

APPLICATION: The student will draw a systems flowchart that employs the Structured Theorem.

ANALYSIS: Using the Top/Down design approach, the student will differentiate the programming modules to their lowest level.

SYNTHESIS: The student will relate, in a flowchart format, the integration of programming modules and systems flows.

EVALUATION: As a member of a Structured Walk-Through team, the student will judge the appropriateness of another students design and recommend possible pitfalls and bottlenecks.

3. e. Instructional objectives derived from goals

Instructional objectives represent the steps the learner needs to take in order to learn and evidence attainment of the performance objective. Thus, instructional objectives are the major subdivisions of instruction which are used to achieve one performance objective.

Derive instructional objectives from one performance objective.

Performance Objective:

The student will draw the three basic structured control structures.

Performance Elements:

Structured Theorem
Flowchart Symbols
Directional Flow Relations
The Three Basic Control Structures (Structured)
Freehand Drawing

Instructional Objectives:

a. To recite verbatum, in class, the Structured Theorem.

b. To draw freehand, circles, rectangles, diamonds, and arrows on the blackboard until they are uniquly distinquishable.

c. To describe each flowchart symbol to a small group to their satisfaction.

d. To differentiate the directional flow of data in a case study and to explain its relationship to the symbols.

e. To match theory, symbols, and arrows to the three structured control structures.

3. f. Sequence of performance objectives

Based on analysis of the key elements of the Performance Objectives and Instructional Objectives, arrange the objectives in order to achieve the goal. Identify any pre-requisites for learning.

Performance Objectives:

Prerequisites for learning:

Effectively Speak
Effectively Write
Effectively Draw Freehand

Sequence of Objectives:

1. The student will identify 10 of the 15 flowcharting symbols' names and relationships.

2. The student will define, in one sentence, the Structured Theorem.

3. The student will draw the three basic control structures.

4. The student shall explain, in his/her own words, the three structured design approaches.

5. Upon reading the case, the student will distinguish the applications major inputs, processes, and outputs.

6. The student will draw a program flowchart that employs the Structured Theorem.

7. Using the Top/Down design approach, the student will differentiate the programming modules to their lowest level.

8. The student will organize the facts and develop a solution based on analysis and design procedures for a given problem.

9. The student will relate, in a flowchart format, the integration of programming modules and systems flow.

3. f. Sequence of performance objectives (Cond't)

10. The student will draw and write design documents to support the solution.

11. As a member of a Structured Walk-Through team, the student will judge the appropriateness of another student's design and recommend possible pitfalls and bottlenecks.

Instructional Objectives:

Prerequisites for learning:

Effectively Speak
Effectively Draw Freehand

Sequence of Objectives:

1. To recite verbatum, in class, the Structured Theorem.

2. To draw freehand, circles, rectangles, diamonds, and arrows on the blackboard until they are uniquely distinguishable.

3. To describe each flowchart symbol to a small group of fellow students.

4. To differentiate the directional flow of data in a case study and to explain its relationship to the symbols.

5. To match theory, symbols, and arrows to the three control structures.

3. g. Analysis of goals for learning styles

Just as instructors have different styles of teaching, individual students have different styles of learning. The research of David Kolb has indicated that different academic disciplines have tended to favor one style of learning over other; thus, students with a particular style of learning may succeed more easily in one subject than another.

Definition of terms:

"Experiential Learning Theory" by David A. Kolb

1. The Experiential Learning Model

   a. Concrete Experience - Students must be able to involve themselves fully, openly, and without bias in new experiences.

   b. Observations and Reflections - Students must be able to observe and reflect on those experiences.

   c. Formation of Abstract Concepts and Generalizations - Students must be able to create concepts that integrate their observations into logically sound theories.

   d. Testing Implications of Concepts in New Situations - Students must be able to use these theories to make decisions and solve problems.

2. Individual Learning Styles

   a. Convergers' dominant learning abilities are Abstract Conceptualization and Active Experimentation. Their greatest strength lies in the practical application of ideas.

   b. Divergers are best at Concrete Experience and Reflective Observation. Their greatest strength lies in imaginative ability.

   c. Assimilators' dominant learning abilities are Abstract Conceptualization and Reflective Observation. Their greatest strength lies in the ability to create theoretical models.

3. g. Analysis of goals for learning styles (Cond't)

d. Accomodators are best at Concrete Experience and Active Experimentation. Their greatest strength lies in doing things, in carrying out plans and experiments and becoming involved in new experiences.

Computer Science Learning Style:

-Authors Teaching Style: Assimilator

-Computer Science Style:

1. Converger - ACM Curriculum Model (ISU).

2. Assimilator - DPMA Curriculum Model (ATU).

-Curricular Goal: Given a data processing application, the student will analyze the problem using structured tools and design the solution in a structured algorithm format.

1. Concrete Experience: Symbols; Structured Theorem; Design Approaches.

   Instructional Strategy: Handouts; Lecture; Question/ Answer.

2. Reflective Observation: Practical application of basic theory and foundation.

   Instructional Strategy: Case study in small groups.

3. Abstract Conceptualization: Design and draw a specific Structured Algorithm.

   Instructional Strategy: Lecture; Handouts; Walk-Throughs.

4. Active Experimentation: Full Structured design in algorithm format.

   Instructional Strategy: Homework; Structured Walk-Throughs; Quiz; Examination.

Adoption Plan Outline

1. Sample presentation to peers
2. Sample goal hierarchy for related fields
3. Step by step adoption plan

1. Sample presentation to peers

Subject: Explaining to a group the component parts of a curriculum.

DISCUSSION:

1. Memo. It is good practice to notify members of a committee or group of a pending meeting with advanced notice. In the case of a group of faculty working on a curricular revision or development project, there are a few basic elements that should be found in the memo. First, the subject should be addressed with a brief description. Who should attend second, followed by the time and place. Faculty are always interested in the length of meetings so it would be advantageous to set a time limit. And last, one may list any references group members should be familiar with and/or enclose any handouts for advanced reading.

2. Considerations. For the Curriculum Consultant, there is a need for planning before the meeting and to set the ground rules at the onset of the meeting. The role of the curriculum consultant is to advise, give direction and opinions based on current curriculum theory: he/she has no authority. Throughout the meeting the consultant must stress the underlying notion of faculty ownership. The feeling of ownership will motiviate discussion and keep the interest at an acceptable level. Faculty have the tendency

to deviate from a given topic so the consultant must be on guard to keep the discussion on the issue. As professionals, faculty members will be interested in change that can benefit the department. However, apathy could appear from a member or two. If you know their area of specialization and/or background, try to relate the issue to their area; involvement is critical to the ownership concept mentioned before. The last consideration is to anticipate questions that may arise, such as:

a. Everything is fine, why do we need to change it?

or

b. We have always done it that way before.

3. Situation. On Friday, October 1st, the author of this paper met with the faculty of the Computer and Management Science Department at Arkansas Tech University. The meeting was held to discuss the revision of CS 190, Structured Methods, which was adopted and offered fall semester, 1981. Essentially, there was disagreement that the course was not delivering the expected results or what was thought to be the expected results (outcomes). The department Head convened the meeting to discuss faults with the course and find solutions. The meeting had a time limit of one hour.

4. Discussion. Mr. Mitchell, may I address the department? The reason we are having this meeting is that the students are not demonstrating the expected outcomes from a course that was initiated last fall, CS 190, Structured Methods. That appears to be the gut feeling of the faculty. But what are we measuring against; what criteria are we using in the evaluation of the course? Could it be the grading system, the background of the faculty who teach the course, methods of instruction, or course content?

Before we discuss what is wrong with Structured Methods and how to resolve it, a short review of curriculum components is in order. In reviewing three National Undergraduate Computer Science Curriculum Guidelines (ACM, DPMA, PLUG), there were three common components: Objectives, Procedure, and Evaluation. (At this point, the presentor will attempt to have the group discover these commonalities so the ownership of the components is theirs.) Basically, objectives are what we expect the student will learn or demonstrate by the end of the course. In conjunction with Structured Methods, students would know the common flowcharting symbols and be able to break down a complex application into a pictorial representation. Procedure is the mechanism the instructor used

to influence the students activity - the learning process. Finally, evaluation informs the instructor at what level the student met the objectives. Evaluation also can be use to modify the procedure so students can meet all the objectives of the course.

The three components relate to each other and all must be applied for a valid curriculum. Without objectives, what is one to teach and how does the instructor know when the students have obtained the level of proficiency desired? The faculty have agreed upon the objectives for the course in Structured Methods and they are still valid today. Procedure, on the otherhand, has not been formalized in word or writing. Only a rough outline of subtopics will be found in the current curriculum. Gentlemen, we seem to have found a topic to discuss in conjunction with our course revision! Every instructor who has tought Structured Methods has spent time and honestly evaluated the students for grading purposes. The abundance of low grades indicate the students are not meeting the stated objectives. Students are also complaining about grading based on different criteria and course content (Objectives/Procedure). Gentlemen, our second topic; Evaluation.

Mr. Mitchell, I return the floor to you for formal discussion of the curriculum revision.

Consultant's Role - Advise;
Give direction; and
Keep the discussion on the issue.

2. Sample goal hierarchy for related fields

A. Levels of goals for: Statistics

National: To acquaint educators with statistical literacy.

Explanation: Educators need to understand the language of statistics because most reports in education present some type of statistical analysis for the data.

Professional Organization: To have each member understand and present findings in statistical reports to other members of the organization.

Explanation: This will enhance opportunity for publication of articles within their area or speciality.

College Division or Department: To provide all students within the department the knowledge and procedure to apply statistical analysis.

Explanation: Students should have an opportunity to learn and understand statistics to enhance their respective professional career.

Course, Seminar, Workshop, Etc: Students will gain the basic concepts of statistical analysis and procedure.

Explanation: Each student enrolled in an introductory statistical course should learn to analyze and interpret basic statistical concepts such as average, mean, standard deviation and correlation.

2. Sample goal hierarchy for fields (Cond't)

B. Levels of goals for: Counselor Education

National: To provide students who are interested in becoming counselors, specific data and programs for post bacculaureate study.

Explanation: In consideration of furthering the profession, data, guidelines, and publications are available.

Professional Organization: To disseminate information to interested persons concerning general aspects of ethics, certification, and other dimensions concering the profession.

Explanation: More specific criteria about the profession.

College Division or Department: To provide students in the department with the knowledge and experience to use counseling procedures in the field.

Explanation: A definition of coherent curriculum and experiences needed for student training.

Course, Seminar, Workshop, Etc: To provide participants awareness and practical experience in drug counseling.

Explanation: A portion of a total design for the training of students in counseling.

3. Step by step adoption plan

A. Organizational Health.

1. Goal Focus.

Although the goals at Arknasas Tech University are clearly stated, the technical aspects have not been followed in the past. Liberal Arts has had the emphasis until 1980. Over the past two years, the technical disciplines have received additional funding and new facilities. Currently, the institution stresses improvment of the technical disciplines. In this light, the curriculum revision is achievable and appropriate.

2. Communication Adequacy.

Structured Methods is a foundation course for upper level coursework in Computer Science. Mathematic and Business major will be affected as they are required to take upper level Computer Science courses. The proposed revision should be address in brief in the Dean's monthly newletter. Meetings must be held with members of the following departments: Business, Engineering, and Mathematics. The meetings would address the change and how it might effect the students.

3. Optimal Power Equalization.

Before any meetings be held outside of the department, the Computer Science faculty must collaborate on the content of the revision. The faculty must also identify the members in other departments whose influence could help or hinder the revision. Finally, it must be determined who should be involved in the presentation of the revision.

4. Resource Utilization.

The proposed revision will not require any additional funding or faculty positions. Nor will it require any shift in course load or the addition or deletion of courses. It will require the Computer Science faculty who teach the course to update their notes and alter their teaching methods based on formal goals and objectives.

5. Cohesiveness.

Members of the department need to have the feeling of ownership for the revision to be successful. All members of the department must collaborate on the revision to insure it meets the needs of all faculty. It is adviseable that each member teach the course after revision. Therefore, the department Head will have to modify the schedule and rotate teaching assignments.

6. Morale.

Morale within the department is on an upswing with the institutions new emphasis on the technical disciplines. One of the major concerns will be the time table for implementation. Faculty need sufficiant time to prepare the course based on new goals and objectives. Teaching of the revised course could start at the beginning of the summer session. Because the faculty feel a real need for revision, involvement and rewards will be forthcoming as an outcome of a better prepared student.

7. Innovativeness.

The goals and objectives need to be identified for the revision process. It is proposed that a series of brainstorming session, maybe over lunch, initiate the project. Formal meetings could then follow that would allow for detail analysis. The revision should still allow for individual innovativeness by the instructor. Faculty members will need some measure of flexibility for individual needs.

8. Autonomy.

The revision must reflect the needs of students, faculty, and industry. However, each are inter-related and cannot be looked upon solely. In the meetings, faculty must weigh the issues of the outside environment to curriculum revision. Industry itself must not be the driving factor.

9. Adaptation.

Historically, the department has responded well to change and pressure from the outside (industry). In the revision process, faculty consensus is needed on the trade off of change, resources and restructing. The adaptation of the revision will not be the end; curriculum revision in computer science is an ongoing and dynamic process.

B. Fifteen Factors in Reducing Resistance to Change.

1. Ownership.

The curriculum revision in Structured Methods will be the result of all members of the department. Full acceptance by faculty can only come about if the innovation is owned by those affected. The revision, through developmental meetings, must be responsive to facultys' needs, diagnosed and designed with their involvement, and implemented with full faculty support.

2. Reduction of Burdens.

The revision will reduce the instructional load in upper division courses. This is, of course, the reason for the change. Department members as well as students will benefit from the changes as they progress through the required courses. Students being better prepared will require less review at the onset of a new course of instruction.

3. Support At The Top.

Although the course revision does not require faculty senate approval, support from the School of Systems Science is important. The department must secure the approval of the Dean. This is necessary as other department Heads may contend the revision is unnecessary. Hopefully, through department Head meetings and proper communication, other officals will see the benefit of the revision.

4. Compatibility With Institutional Values.

Arkansas Tech University and ATU's School of Systems Science stress the quality of education received at the institution. The perception of the revision must follow the traditional values and goals of educational excellence. Proper foundation on the faculty's part should offer quality solutions.

5. Compatibility With Organizational Structure.

The revision to Structured Methods fits into the current course requirements. There will be no new courses as prerequistes or deletions of old courses. The department must clarify to other faculty, within the School of Systems Science, that the revision will be a major benefit for all students who desire to study computer science. This can be transmitted through the Dean's Monthly Newsletter.

6. Desire of New Experience.

Computer Science faculty are dynamic in nature. They feed on new ideas and change. The revision, as put forth by the department Head, should challenge the faculty for best results.

7. Respect For The Opposition.

Department Heads and faculty from Business, Engeering, and Mathematics may resist any change to foundation courses. Preliminary meetings need to be scheduled to discuss proposed changes and to acquire their feedback. Some of their concerns may be valid and the revision could be modified. Their input and cooperation is essential.

8. Clear Goals.

The reason for the revision is to formalize goals and objectives. Foggy goals lead to the present situation. Sufficient time and thought by the faculty will be necessary. A series of short meeting and passing around written ideas is suggested to start the process.

9. Open, Two-Way Communication.

Flow of information, both ideas and outcomes, must be presented in a timely manner. Careful consideration is needed on the model of governance in practice: Bureaucratic, Political, Collegium, or Technocratic. Feedback from participants and officials is a basic requirement. The department Head should offer his service and advice to other colleagues. All Computer Science faculty will be tasked with gathering and dissemination of information informally.

10. Bugs Inevitable.

Department faculty are aware that any revision could help to eliminate the present deficiency. Being professionals, this may well be the case; however, it is possible it could miss the mark. Curriculum design is an ongoing process and faculty should be made aware that the needs change as time passes. This can be stressed through professional development seminars.

11. Training For New Roles.

It is not unusual in curriculum design or revision for faculty to take on new roles or at the least modify them somewhat. The proposed revision requires no new roles or training thereof.

12. Suitable Materials.

The revision, which will incorporate revised goals and objectives, will require new teaching materials. These materials will take at least one semester to prepare. Full participation of the department faculty will be required. Monthly meetings will be established to review proposed materials. All materials prepared shall be available to all faculty.

13. Unexpected Effects.

It is possible that the revision change could be a great benefit to the institution, faculty, and students. On the other hand, bad side effects could also take place. All department faculty will be advised to be on the lookout for good and bad side effects. Any effects noticed, shall be discussed at the next scheduled department meeting.

14. Rewards.

A rule of thumb is that participants should be rewarded at least as fully as are those in traditional learning, teaching and research pursuits. Individual faculty satisfaction and student development is what one could expect from the curriculum revision. That in itself is enough and all will be satisfied within the department.

15. Climate of Readiness.

The Computer Science Department needs to keep the institution informed, not only of curriculum revision, but on the fast pace of computer technological change. Information could be distributed through the use of a quarterly newsletter. The climate for change would be apparent by the dynamics of the computer industry. In addition, the faculty of the department could make themselves available for inservice seminars and briefings.

Sample Unit of Instruction

1. A performance objective
2. Explanation of how objectives and learning activities are different
3. Sequence of instructional objectives
4. Analysis of an instructional objective for learning style
5. Unit of instruction - three examples:
   a. Learning strategy
   b. Outline of unit
   c. Evaluation methods

1. A performance objective

After completing this lesson, the student will draw and write the names of the three basic control structures.

2. Explanation of how objectives and learning activities are different

In order to develop curriculum, a curriculum specialist must be able to distinguish between a learning activity and a performance or instructional objective. A common mistake in curriculum design can be overcome with relative ease.

Although often confused, there is a difference between an objective and a learning activity. While an objective describes the desired end behaviors or attitudes to be learned and evidenced by the student, the learning activity is a sequence of experiences designed for students so that they may achieve a particular instructional objective.

The instructional objective contains (a) observable behavior, (b) conditions under which that behavior will occur, and (c) standards of performance for that behavior.

The learning activity is dependent upon (a) teaching methods (i.e., lecturing, individualized instruction, etc.), (b) instructional materials, and (c) instructional media.

In planning an educational program to attain a given objective, the instructor must decide on learning activities to be provided, since it is through this experience that learning actually will take place to meet a given instructional objective. The teacher must then organize the selected methods and materials into lesson plan for implementation. (Course notes authored by Dr. James Ratcliff, Curriculum Development in Colleges.)

3. Sequence of instructional objectives

Performance Objective:

The student will draw the three Structured control structures.

Instructional Objectives:

Prerequisites for learning:

Effectively Speak
Effectively Draw Freehand

Sequence of Objectives:

1. To recite verbatum, in class, the Structured Theorem.

2. To draw freehand, circles, rectangles, diamonds, and arrows on the blackboard until they are uniquely distinguishable.

3. To describe each flowchart symbol to a small group of fellow students.

4. To differentiate the directional flow of data in a case study and to explain its relationship to the symbols.

5. To match theory, symbols, and arrows to the three control structures.

4. Analysis of an instructional objective for learning style

Explanation:

In using different styles of learning, students come to rely on different senses as the primary sense for learning. If instructional plans address more than one sense, the breath of learning styles can be more easily addressed.

Instructional Objective: To match theory, symbols, and arrows in the construction of the three control structures.

Directions:

Identify a teaching method and an instructional aid for as many senses listed as you can.

Sense	Teaching Method	Instructional Aid
Hearing	Lecture	Advanced Organizers Handouts Blackboard Overhead Movie
Smell	N/A	N/A
Sight	Computer Assisted Instruction	Computer Color Graphics Programmed Text Advanced Organizers
Speaking	Student Presentation	Handouts Charts Overhead Blackboard
Touch	Drawing	Computer Computer Graphics with light pen Programmed Instruction

5. Unit of instruction

UNIT

This lesson is to be included in an overall unit dealing with theory and symbolism in use of control structures. It should be introduced prior to the lesson on program flowcharting.

BEHAVIORAL OBJECTIVE

Given the definition of the Structured Theorem, flowcharting symbols and 7 case examples, the student will match the case examples to a control structure with 100% accuracy.

RATIONALE

A clear understanding of program flowcharting requires that students differentiate control structures and symbols with theory.

CENTRAL IDEA

The use of control structures in program flowchart design.

TEACHING METHOD: Computer Assisted Instruction

CONTENT	PROCEDURES (STRATEGIES)
1. Definition of Structured Theorem	a. Students will be prompted by the computer to choose the correct difination in a multiple choice mode.
	b. The computer will ask the student to keypunch the definition and check for accuracy.
2. Flowcharting Symbols	a. Using computer color graphics, each symbol will be drawn with it's corresponding name and function.
	b. Students may prompt the computer to redraw any symbol until they have mastered the concept.
3. Organization of Control Structures	a. Using computer colored graphics, the three control structures will be demonstrated with proper text.
	b. Using a light pen, students will indicate the flow of information. If not correct, the computer will reprompt the student for the correct answer.
	c. Examine case study based on programmed text and advanced organizers.

EVALUATION PROCEDURES

At the end of the week, the students will be administered a short quiz. A list containing 7 case examples randomly arranged shall be passed out. Have the students underline the appropriate name to its corresponding control structure for each case. When students have finished, have them exchange papers and as a group score the correct answers. Retrun papers to students for immediate feedback. After noting how many didn't succeed through a show of hands, provide additional instruction so that mastery of the terms and theory will be accomplished. Direct students to reuse the Computer Assisted Instruction lesson again.

MATERIALS AND AIDS

A programmed text on the concepts of structured control structures and how to use the computer CAI lesson.

TEACHING METHOD: Lecture

CONTENT	PROCEDURES (STRATEGIES)
1. Definition of Structured Theorem	a. Ask students if they know what the Structured Theroem is based on advanced organizers. b. Ask students to give examples of the defination and write them down and project them using an overhead projector. c. Write a student-derived definition of the therom and project it via the overhead. d. Project the instructors definition aside the students'. e. Compare the two definations and have the students copy the formal definition.
2. Flowcharting Symbols	a. Draw, name, and discuss each symbol using the blackboard. b. Discuss the function of each symbol with the others based on the handouts of examples.
3. Organization of Control Structures.	a. Demonstrate how to develop control structures based on theory using the blackboard. b. Ask students to draw the three control structures on paper; identify the flow of direction.

c. Examine case study examples and ask students to match logic with structured design.

EVALUATION PROCEDURES

After students appear to be able to distinguish control structures on the lists projected on the screen, pass out a list containing 7 case examples randomly arranged and have students underline the appropriate name. When students have finished, have them exchange papers and as a group score the correct answers. Return papers to students for immediate feedback. After noting how many didn't succeed through a show of hands, provide additional instruction so that mastery of the terms will be accomplished.

MATERIALS AND AIDS

Advanced organizer on material as deemed appropriate by the instructor. Blackboard with colored chalk. Overhead projector, marking pen, blank transparencies, one or two transparencies with control structures and direction of flow.

TEACHING METHOD: Student Presentation

CONTENT	PROCEDURES (STRATEGIES)
1. Definition of Structured Theorem	a. A student will discuss the definition based on advanced organizers and write the definition on the blackboard. b. Once the definition is formalized, each student will copy the definition in his/her notes.
2. Flowcharting Symbols	a. Ten students will draw and present a discussion on one symbol based on advanced organizers. b. Students in class will be asked to discuss the function of each symbol in relation to the others.
3. Organization of Control Structures	a. Three students will demonstrate how to develop control structures based on theory by drawing on the blackboard. b. Student presentors will discuss and diagram the direction of information based on logic.

EVALUATION PROCEDURES

At the end of the student presentation, pass out a list containing 7 case examples randomly arranged and have students underline the appropriate name. They are to take the assignment home and write a short essay answer for each case example. After the paper is graded and returned, provide additional instruction so that mastery of the terms and theory will be accomplished.

MATERIALS AND AIDS

Advanced organizer on the Structured Theorem and control structures. Blackboard with colored chalk. Overhead projector, marking pen, blank transparencies, one or two transparencies with control structures and direction of flow.

Ainsworth, D. "Examing the Basis for Contempory-Based Education", Journal of Higher Education 48, (May/June 1977): 321-332.

The article suggest that the prime contribution of competency-based education has been its focus on achievement as opposed to instruction. It also examines the concept of competency attainment in the light of prictical experience at a competency-based institution.

Bergquist, William H., Gould, Ronald A., and Greenberg, Elinor M., Designing Undergraduate Education, San Francisco, Jossey-Bass Publishing Co., 1981.

The authors identify and systematically examine the six major components of contemporary undergraduate programs - time, space, resources, organization, procedures, and outcomes. They also describe and evaluate a wide range of program designs, from the most traditional to the highly innovative, pointing out their strengths and weaknesses and explaining how colleges successfully deal with problems of shifting student interests and diminishing resources.

Doll, Ronald C., Curriculum Improvement: Decision Making and Process, Boston, Mass., Allyn and Bacon, Inc., 1970.

The book is divided into three parts:
(1) Decision making involved in what a curriculum shall be;
(2) Process in improving the curriculum; and
(3) Evaluation of curriculum improvement programs.

This book would be a help for curriculum designers working on courses, seminars, and workshops.

Dressel, Paul L., "College and University Curriculum", MrCutchan Publishing Co., Berkeley Calif, 1971.

Dressel discusses 11 Curriculum Models vrs. Bergquist who offers 8. There are some major differences. Make sure you read both references. He offers three Philosophies of Education: Traditionalist, Eclectic, and Relativist.

Steps in curricular development
a. Defn of Objectives
b. Selection of Objectives
c. Organization of Experiences
d. Evaluation

Eisele, James E., "Computer Assisted Planning of Curriculum and Instruction", Educational Technology Publications, Englewood Cliffs, New Jersey, 1971.

Component parts of a curriculum: Objective, Procedure, Implementation, Feedback, Implications, and Conclusion.

This book discussed how a curriculum designer can use computers for individualized instruction. Chapter II is an excellent resource and guide for individualization. It also contains a list of Learner Variables within the package for consideration. Chapter 5 - Computer Assisted Planning as a Vehicle for Curriculum Evaluation and Research. The author contends that computer assisted instruction is, and could be, an extremely powerful research tool as the research could control variables.

Kebler, Robert J., and Barker, Larry L., and Miles, David T., Behavioral Objectives and Instruction, Allyn and Bacon, Inc., Boston, 1970, pp. 44-101, 177-188.

1. It presents material relative to behavioral objectives from a variety of sources in a single volume.
2. It presents a classroom-tested model of instruction that illustrates the relationship of behavioral objectives to the instruction-learning process.
3. It prescribes an approach to objectives based on planning instruction and informing others of instructional goals.
4. It presents an orginal, taxonomic classification for the psychomotor domain.

Lindquist, Jack, "Strategies for Change", Pacific Sounding Press, Berkeley, Calif., 1978.

This book examines strategies for change that occured at specific institutions. By reviewing past history, the author feels it will help solve problems for institutions in higher education. Good overview of how the governance works in the change process.

Riley, Gary L., and Baldridge, J. Victor, Governing Academic Organizations, McCutchan Publishing Co., Berkeley, Ca., 1977.

This book discusses the basic models of college governance. At the institutional level, it looks into innovation and change. Excellent reference if one needs to deal with upper management.

Taba, Hilda, Curriculum Development Theory and Practice, New York, Harcourt Brace & World Inc., 1962.

This books examines the theory of curriculum development, and reaches into fields other than education for strengthening thinking about curriculum and how to link what has transpired with current ideas and problems.

Taylor, Johnson, Curriculum Development, New York, NFER Publishing Co., 1971.

The book makes available to the reader the definition of curriculum, the style of curriculum development, an appraisal of curriculum development and the future of curriculum development.

Tyler, Ralph, Basic Principles of Curriculum and and Instruction, Chicago University, Chicago, Ill., 1949.

The author explains the rationale for viewing, analyzing, and interpreting the curriculum and and instructional programs in an educational institution.

Wiles, Jon, and Bondi, Joseph, Curriculum Development A Guide to Practice, Merrill Publishing Company, Columbus, Ohio, 1979.

This book has a good discussion on the five educational philosophies: Perennialism, Idealism, Realism, Experimentalism, and Existentialism. There is a good section on goal clarification.

Excellent reference on Bloom's Taxonomy of Educational Objectives. There is a cross reference chart on Cognitive Behavior, Affective Behavior, and Psychomotor.